

# ALGEBRA 1

## UNIT 1 • LESSON 1

# Properties of Real Numbers

Classify • Properties • Sets • Repeating Decimals

Goal: classify real numbers, use key properties, combine sets, and explore repeating decimal patterns.

*Access IDEAS presents a customized session for Algebra 1, Unit 1, Lesson 1.*



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# Agenda

- Introduction: Instructor and Students
- Course Content, Format, and Rules
- Classify Real Numbers
- Properties of Real Numbers
- Sets: Intersection and Union
- Bonus Material: Divide  $\frac{1}{3}$ ,  $\frac{1}{7}$ , and  $\frac{1}{9}$

# Introduction: Instructor and Students

- Instructor Introduction - Jack Chung
- Student Introductions (*take attendance*)
  - Name
  - Why do you want to take this class?
  - Please share if you have any expectations for this course.
- Not a replacement for a fully accredited Algebra I course
  - Introduce concepts
  - Supplement students' math learning

# Course Content, Format, and Rules (1)

- Plan to cover over 80% of Algebra curriculum
- This mini-course is only for **Unit 1: Expressions and Operations**
  - Week 1 (9/23): Introduction to Class, Properties of Real Numbers
  - Week 2 (9/30): Order of Operations, Simplifying/Evaluating Expressions
  - Week 3 (10/7 ?? ): Distributive Property
  - Week 4 (10/14 ?? ): One-variable Statistics
- Preparation and Practice
  - **Required: assigned video(s) to watch** (unless taking Algebra 1 currently)
    - *Please post in chat if you watched the video for lesson one.*
  - Optional: weekly problem set, unit quiz

## Course Content, Format, and Rules (2)

- First 10-15 minutes – one or more of the following:
  - Review questions from previous assignment that students found most challenging
  - Reinforce important concepts from basic math
  - Sample math competition questions
- Next 40-50 minutes
  - Go over key concepts
  - Provide examples and work through solutions
- Last 30 minutes
  - Students ask follow up questions on what was taught in this Unit
  - Answer any questions related to Algebra (e.g. help with homework/quiz)

*Students are encouraged to send screenshots of questions ahead of time*

## Course Content, Format, and Rules (3)

- Inform instructor if student will miss or be late to session
  - algebra@access-ideas.org
  - Copy of slides will be uploaded to website
- Problem sets and quizzes turned in after due date may not be graded
- Student video will be optional during class sessions
  - Students are recommended to blur their backgrounds or have virtual backgrounds
  - If students are not engaged, we will revisit “camera policy” for the next unit
- Students need to “cc” parents on all emails to me
  - If they forget, I will include parent(s) in my response
- Any other questions?

# Unit 1

We will now start our first lesson of Algebra - Unit 1.

# Classify Real Numbers

Real numbers are organized into nested sets. We will talk about “sets” at the end of the lesson.

1

## NATURAL

Counting numbers: 1, 2, 3, ...

2

## WHOLE

Natural numbers together with 0.

3

## INTEGER

Whole numbers and their opposites.  
Examples: 0, 1, -1, 2, -2, 3, -3, ...

4

## RATIONAL

Can be written as  $a/b$ ,  
where  $b \neq 0$ .  
Examples:  $\frac{1}{2}$ ,  $\frac{3}{4}$ ,  $\frac{13}{7}$

5

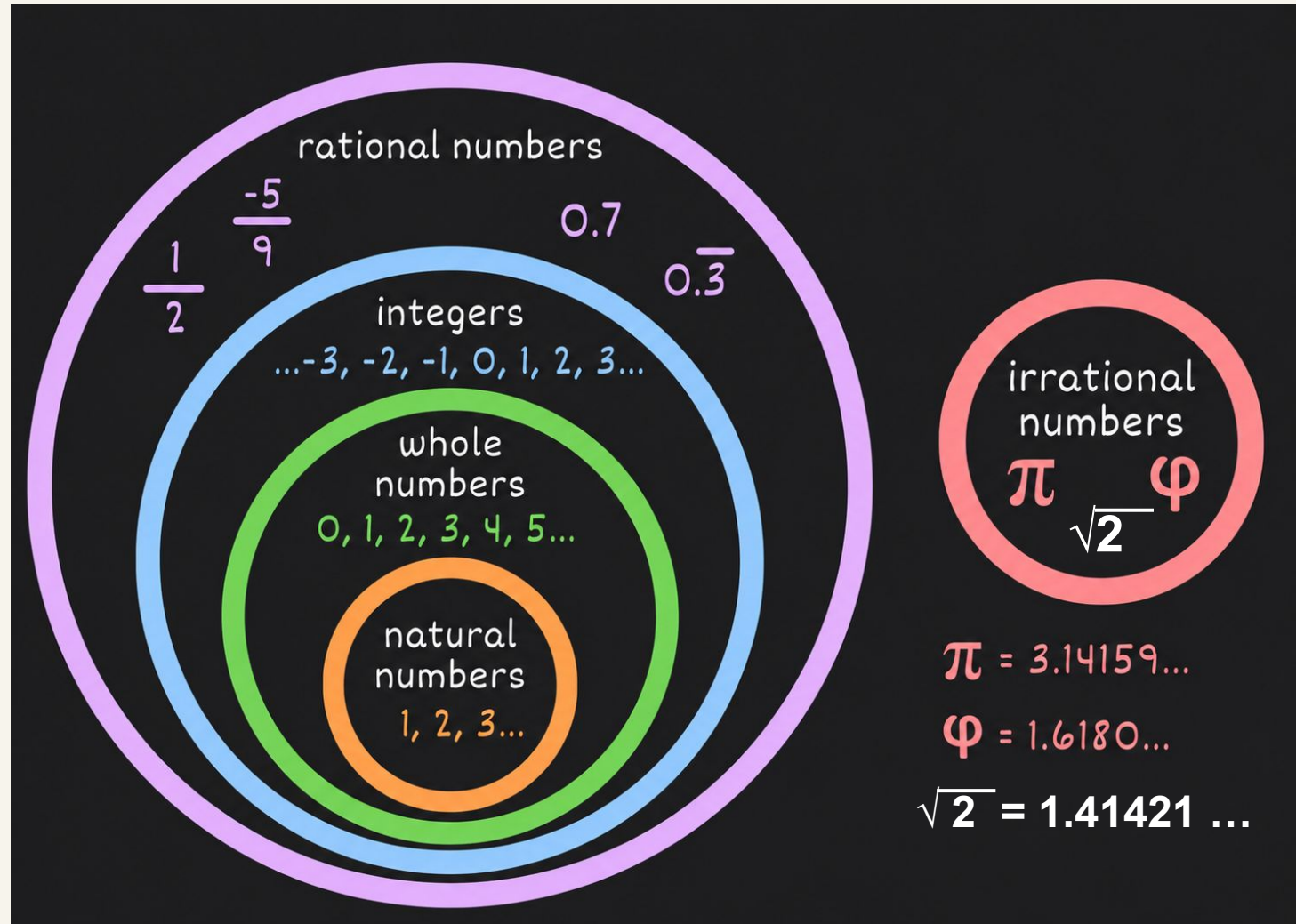
## IRRATIONAL

Cannot be written as a ratio;  
decimals never end or repeat.  
Examples:  $\pi$ ,  $\sqrt{2}$

What happens when you divide by 0?  
If there are Real numbers, what are Imaginary numbers?

# Classify Real Numbers

How the real-number sets fit together.



# Classify Real Numbers

Simplify first, then classify from the smallest set outward.

1

## SIMPLIFY

Evaluate radicals, powers, and signs before classifying.

2

## CHECK INTEGER

Whole numbers and their opposites are integers.

3

## CHECK RATIO

Fractions and terminating or repeating decimals are rational.

4

## CHECK IRRATIONAL

Nonperfect roots and non-repeating decimals are irrational.

5

## INCLUDE REAL

Every rational or irrational number is real.

# Classify Real Numbers — Practice 1

Classify  $-\sqrt{49}$  in every real-number set to which it belongs.

- Real?
- Natural (Counting)?
- Whole?
- Integer
- Rational?
- Irrational?

Please post your answer in chat.

## Classify Real Numbers — Worked Solution

Classify  $-\sqrt{49}$  in every real-number set to which it belongs.

### SOLUTION

$$-\sqrt{49}$$

$$-7$$

integer

rational

real

$$\sqrt{49} = 7$$

*Apply the negative sign*

*-7 is an integer*

$$-7 = -7/1$$

*Rational numbers are real*

**Answer: integer, rational, and real.**

## Classify Real Numbers — Practice 2

Classify 0.125 in every real-number set to which it belongs.

- Real?
- Natural (Counting)?
- Whole?
- Integer
- Rational?
- Irrational?

Please post your answer in chat.

# Classify Real Numbers — Worked Solution

Classify 0.125 in every real-number set to which it belongs.

## SOLUTION

**0.125**

**125/1000**

**1/8**

**rational**

**real**

*Write as a fraction*

*Simplify the fraction*

*Ratio of integers*

*Rational numbers are real*

**Answer: rational and real.**

## Classify Real Numbers — Practice 3

Classify  $\sqrt{18}$  in every real-number set to which it belongs.

- *This time, I am not going to list the different sets to see if you remember*

Please post your answer in chat.

## Classify Real Numbers — Worked Solution

Classify  $\sqrt{18}$  in every real-number set to which it belongs.

### SOLUTION

$$\sqrt{18}$$

$$\sqrt{(9 \cdot 2)}$$

$$3\sqrt{2}$$

irrational

real

*Factor out a perfect square*

$$\sqrt{9} = 3$$

*$\sqrt{2}$  is irrational*

*So  $3\sqrt{2}$  is irrational*

**Answer: irrational and real.**

# Properties of Real Numbers

Properties let us rewrite expressions without changing their value.  
For any real numbers  $a$ ,  $b$ , and  $c$ :

| Property                                | Addition                                      | Multiplication                              |
|-----------------------------------------|-----------------------------------------------|---------------------------------------------|
| <b>Commutative</b><br>(Change order)    | $a + b = b + a$                               | $a \cdot b = b \cdot a$                     |
| <b>Associative</b><br>(Change grouping) | $(a + b) + c = a + (b + c)$                   | $(a \cdot b) \cdot c = a \cdot (b \cdot c)$ |
| <b>Identity</b>                         | $a + 0 = a$                                   | $a \cdot 1 = a$                             |
| <b>Inverse</b>                          | $a + (-a) = 0$                                | $a \cdot (1/a) = 1, a \neq 0$               |
| <b>Closure</b>                          | $a + b$ is a real number.                     | $a \cdot b$ is a real number.               |
| <b>Distributive</b>                     | $a(b + c) = ab + ac$ and $(b + c)a = ba + ca$ |                                             |

Do you see Subtraction or Division in the table above?

# Properties of Real Numbers — Practice 1

Name the property:  $12 + 0 = 12$ .

Please post your answer in chat.

# Properties of Real Numbers — Worked Solution

Name the property:  $12 + 0 = 12$ .

## SOLUTION

$$12 + 0 = 12$$

0 is the identity

The value stays 12

*Adding 0 changes nothing*

*Form:  $a + 0 = a$*

***Answer: Additive Identity Property.***

## Properties of Real Numbers — Practice 2

Name the property:  $4(x + 3) = 4x + 12$ .

Please post your answer in chat.

# Properties of Real Numbers — Worked Solution

Name the property:  $4(x + 3) = 4x + 12$ .

## SOLUTION

$$4(x + 3)$$

$$4 \cdot x + 4 \cdot 3$$

$$4x + 12$$

*Multiply 4 by each term*

**Answer: Distributive Property.**

## Properties of Real Numbers — Practice 3

Name the property:  $(a + b) + c = a + (b + c)$ .

Please post your answer in chat.

# Properties of Real Numbers — Worked Solution

Name the property:  $(a + b) + c = a + (b + c)$ .

## SOLUTION

$$(a + b) + c$$

$$a + (b + c)$$

Order stays  $a, b, c$

*Only grouping changes*

*No terms move*

*Addition is associative*

**Answer: Associative Property of Addition.**

## Properties of Real Numbers — Practice 4

Name the property:  $6 + (-6) = 0$ .

Please post your answer in chat.

# Properties of Real Numbers — Worked Solution

Name the property:  $6 + (-6) = 0$ .

## SOLUTION

$$6 + (-6)$$

$$0$$

*A number plus its opposite*

*The opposite is known as “inverse”*

*The sum is 0*

**Answer: Additive Inverse Property.**

# Sets: Intersection and Union

Set notation organizes collections and compares their members.

## 1 SET

A collection written with braces  
Example:  $A = \{1, 2, 3\}$ .

## 2 ELEMENT

The symbol  $\in$  means “is an element of.”

## 3 INTERSECTION

$A \cap B$  contains elements shared by both sets.

## 4 UNION

$A \cup B$  contains every element in either set.

## 5 NO REPEATS

Write each element only once in a union.

## Sets: Intersection and Union — Practice 1

Let  $A = \{1, 2, 3, 4\}$  and  $B = \{3, 4, 5\}$ . Find  $A \cap B$ .

Please post your answer in chat.

## Sets: Intersection and Union — Worked Solution

Let  $A = \{1, 2, 3, 4\}$  and  $B = \{3, 4, 5\}$ . Find  $A \cap B$ .

### SOLUTION

$A = \{1, 2, 3, 4\}$

$B = \{3, 4, 5\}$

Shared: 3, 4

$A \cap B = \{3, 4\}$

*List set A*

*List set B*

*Keep elements in both*

*Use  $\cap$  for intersection*

**Answer:  $A \cap B = \{3, 4\}$ .**

## Sets: Intersection and Union — Practice 2

Let  $A = \{1, 2, 3, 4\}$  and  $B = \{3, 4, 5\}$ . Find  $A \cup B$ .

Please post your answer in chat.

## Sets: Intersection and Union — Worked Solution

Let  $A = \{1, 2, 3, 4\}$  and  $B = \{3, 4, 5\}$ . Find  $A \cup B$ .

### SOLUTION

$A = \{1, 2, 3, 4\}$

$B = \{3, 4, 5\}$

Combine all elements

Remove repeats

$A \cup B = \{1, 2, 3, 4, 5\}$

*List set A*

*List set B*

*Use elements from either set*

*Write each element once*

**Answer:  $A \cup B = \{1, 2, 3, 4, 5\}$ .**

# Bonus Material: Divide $\frac{1}{3}$ , $\frac{1}{7}$ , and $\frac{1}{9}$

Long division reveals repeating decimal patterns.

1

## Repeat

If the decimals repeat, it can be written as a fraction.

This means the number is rational

2

## BAR NOTATION

A bar shows the digit or “group of digits” that repeats.

3

## SPECIAL FRACTION

We will be learning  $\frac{1}{3}$ ,  $\frac{1}{7}$ ,  $\frac{1}{9}$ , and  $\frac{1}{99}$

## Bonus Material: Divide $\frac{1}{3}$

Use long division to write  $\frac{1}{3}$  as a decimal.

## Bonus Material: Divide $\frac{1}{3}$ — Solution

Use long division to write  $\frac{1}{3}$  as a decimal.

### SOLUTION

$$\begin{array}{r} 3 \overline{) 1.0} \\ \underline{-9} \\ 1 \end{array} \quad \begin{array}{r} 3 \overline{) 1.00} \\ \underline{-9} \\ 10 \\ \underline{-9} \\ 1 \end{array} \quad \begin{array}{r} 3 \overline{) 1.000} \\ \underline{-9} \\ 10 \\ \underline{-9} \\ 10 \\ \underline{-9} \\ 1 \end{array}$$

*3 goes into 10 three times  
The remainder repeats  
And you follow the  
same steps  
Use bar notation to  
represent “repeat”*

**Answer:  $\frac{1}{3} = 0.333... = 0.\overline{3}$**

**$\frac{2}{3} = 0.666... = 0.\overline{6}$**

## Bonus Material: Divide $1/7$

Use a calculator to write  $1/7$  as a decimal.  
*(I am not going to make you do long division)*

$$1/7 = 0.142857142857\dots$$

$$= 0.\overline{142857}$$

Guess what is  $2/7$  as a decimal?  
How about  $3/7$ ?

## Bonus Material: Divide 1/7

- $1/7 = 0.\overline{142857}$ 
  - Think of this as pairs: “14”, “28” (double), “57” (double plus 1)
  - There are 6 numbers. What is the next largest number?  $\rightarrow 2$
- So  $2/7 = 0.\overline{285714}$
- Next largest number is 4, so we will use that for 3/7, and so forth
- $3/7 = 0.\overline{428571}$
- $4/7 = 0.\overline{571428}$
- $5/7 = 0.\overline{714285}$
- $6/7 = 0.\overline{857142}$

## Bonus Material: Divide $1/9$

Use a calculator to write  $1/9$  as a decimal.  
*(I am not going to make you do long division)*

$$1/9 = 0.11111\dots$$

$$= 0.\overline{1}$$

Guess what is  $2/9$  as a decimal?  
How about  $3/9$ ?

## Bonus Material: Divide 1/9

- $1/9 = 0.\overline{1}$
- $2/9 = 0.\overline{2}$
- $3/9 = 0.\overline{3}$  (This is the same as  $\frac{1}{3}$ )
- $4/9 = 0.\overline{4}$
- $5/9 = 0.\overline{5}$
- $6/9 = 0.\overline{6}$  (This is the same as  $\frac{2}{3}$ )
- $7/9 = 0.\overline{7}$
- $8/9 = 0.\overline{8}$

## Bonus Material: Divide 1/99

- $1/99 = .0101010101\dots = 0.\overline{01}$
- $2/99 = 0.\overline{02}$
- $3/99 = 0.\overline{03}$
- 
- $10/9 = 0.\overline{10}$
- $15/9 = 0.\overline{15}$
- 
- $83/99 = 0.\overline{83}$

## Bonus Material: Divide 2/11

Write 2/11 as a decimal.

*(Do not use long division. Do not use calculator.)*

$$2/11 = ???$$

Hint: Write as  $x/99$

## Bonus Material: Divide 2/11

Write 2/11 as a decimal.

*(Do not use long division. Do not use calculator.)*

$$\begin{aligned} 2/11 &= 18/99 \\ &= 0.18181818... \\ &= 0.\overline{18} \end{aligned}$$

## Classify Real Numbers — Practice 4

Classify  $0.777\ldots$  in every real-number set to which it belongs.

- Real?
- Natural (Counting)?
- Whole?
- Integer
- Rational?
- Irrational?

Please post your answer in chat.

## Classify Real Numbers — Worked Solution

Classify  $0.777\ldots$  in every real-number set to which it belongs.

### SOLUTION

$0.777\ldots$

$7/9$

rational

real

*The digit 7 repeats*

*Repeating decimals are fractions*

*$7/9$  is a ratio of integers*

*Rational numbers are real*

***Answer: rational and real.***

## Extra Problem

This is a glimpse of what we will learn in later in the course.

We went over these problems in class today.  
It is ok if you don't fully understand since will cover in detail later.

## Extra Problem #1

What is  $x$ ?

$$3x + 2 = 8$$

This is extra material. We will go over in a future session.

## Extra Problem #2

$$y = 3x + 2$$

- x-intercept?
- y-intercept?
- slope?
- graph?

This is extra material. We will go over in a future session.

### Extra Problem #3

What are  $x$  and  $y$ ?

$$2x + 3y = 7$$

$$x + y = 3$$

This is extra material. We will go over in a future session.



THANK YOU

# Access IDEAS

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